16

REPORT

ON THE

REFUSE MATTERS

OF THE

ST. ROLLOX WORKS,

AND THEIR EFFECT ON THE WATER OF THE RIVER CLYDE.

BY

THOMAS ANDERSON, M.D.,

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF GLASGOW.

AUGUST, 1865.

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At Glasgow, the 23rd day of August, 1865.—
Convened the Committee of the Clyde Trustees on the St. Rollox Refuse.

There was submitted to the Committee a Report by Dr. Anderson, Professor of Chemistry in the University of Glasgow, under the Remit made to him by the Trustees, with reference to the refuse and deleterious substances conveyed into the Clyde from the St. Rollox Works. Which Report, having been read and deliberately considered, the Committee appoint the same to be printed and circulated among the Trustees with a view to the farther instructions of the Trustees being taken on the subject.

The following is a copy of the Report by Dr. Anderson :—

REPORT ON THE REFUSE MATTERS OF THE ST. ROLLOX WORKS AND THEIR EFFECT ON THE WATER OF THE RIVER CLYDE.

In accordance with the instructions of the Clyde Trustees, I have submitted the entire question of the nature of the Refuse Matters from the Works of Messrs. Tennant & Co., at St. Rollox, and their effect on water of the River Clyde, to a very minute examination.

In order that the amount and character of these refuse matters may be distinctly understood, it is necessary in the first place to explain succinctly the nature of the operations

carried on at St. Rollox. The substances produced there are Soda, Bleaching Powder, and Soap, and their manufacture necessitates that of large quantities of sulphuric and muriatic acids which are almost entirely consumed within the works, the amount sold being comparatively small.

The first step in the manufacture consists in the preparation of sulphuric acid by burning sulphur, and subjecting the product to certain processes which it is not necessary to particularize. The sulphuric acid so obtained is used to convert common salt into sulphate of soda, and the muriatic gas which is then evolved, is condensed and used for the manufacture of chlorine. At one time muriatic acid was the most offensive and injurious refuse of a soda work, having been allowed to escape into the air, but for many years back it has been condensed at St. Rollox, and this process has now been rendered imperative in all such works by the Alkali Works Act, which requires the manufacturer to condense 95 per cent. of the muriatic acid he produces. Owing to the efficiency of the condensers used at St. Rollox, the requirements of that Act are materially exceeded, and 98 per cent. of the acid is condensed. Although the quantity of gas thus condensed is very large, the magnitude of the works is such that even the small per centage of muriatic acid which escapes is sufficiently large to be worthy of notice. It is understood that upwards of 15,000 tons of soda are annually manufactured at St. Rollox, with the productions of about 10,000 tons of muriatic acid gas, so that even with this thorough condensation, at least 200 tons of the gas must escape into the air every year, which is equal to more than half a ton, or above 12,000 cubic feet of the gas daily, and the requirements of the Alkali Works Act would be fulfilled even if this quantity rose to 1·37, tons or 32,000 cubic feet.

The condensed muriatic acid is employed for the manufacture of chlorine by heating it with manganese in large stone retorts, and the fluid remaining after this operation, which consists of chloride of manganese with a certain quantity of unused acid, was formerly a refuse. Within the last eight or

nine years, however, a process has been devised by which the manganese can be recovered from this fluid, so as to use it a second time, and the refuse then obtained is a solution of the chloride of calcium mixed with a small quantity of acid fluid, which is got in washing out the manganese stills.

The sulphate of soda already referred to is converted into soda ash by a rather complicated series of operations, which it is unnecessary to describe at length, and the only refuse from this process is a solid substance accumulating in large quantities at that part of the works which lies near the Caledonian Railway. This substance, familiarly called "Soda Waste," consists chiefly of a compound known to chemists by the name of oxysulphide of calcium, and is left behind when the soda is extracted by water.

Setting aside the muriatic acid and sulphurous acid which escape into the air in consequence of the inevitable imperfections of the apparatus in use, and are so much valuable matter lost to the manufacturer, the refuse matters from the St. Rollox Works are two in number.

1. The fluid from the chlorine process.
2. The solid matter or waste from the soda.

The nature of the first of these depends upon whether the process for the recovery of the manganese is used or not, and that again is dependent on the price of the material. When manganese is cheap, the process cannot be profitably employed, and then the acid liquor is simply discharged into the drains; but it is only under very special circumstances that this is likely to occur, and I believe that at St. Rollox the whole of the manganese is now recovered.

The refuse in that case is a colourless, transparent, inodorous fluid, consisting entirely of a solution of chloride of calcium, and perfectly free from acid; but, owing to the admixture with it of the washings from the chlorine stills, it is always slightly acid as it is discharged. A sample of this fluid, as it escaped from the discharge pipe at St. Rollox, was found to contain 179·68 grains of solid matters per gallon, which consisted of chloride of calcium, with a little

manganese, and a small quantity of free acid. The whole of this fluid is discharged into the Clyde through the High Street sewer. As far as nuisance is concerned, it must be considered as quite innocuous, for it has no smell; and, consisting entirely of mineral matters, it is incapable of undergoing decay or putrefaction. I am of opinion thus far that this refuse is comparatively unimportant, and I do not think that the Trustees should proceed against it on the ground of nuisance, unless they are prepared to take up the position that no manufacturing refuse of any kind shall be discharged into the river. To its effect on iron and copper sheathing, reference will be made in a subsequent part of this Report.

The solid refuse from the soda process, which is stored in large heaps on the north side of the Works consists, as already observed, of the oxysulphide of calcium, a substance insoluble in water, but liable to be decomposed by the action of the air. The carbonic acid contained in the atmosphere acts on it, splitting it up into carbonate of lime, and sulphide of calcium—and the latter being easily soluble in water, is dissolved and washed out by the rain which penetrates the heap. Great care is taken at St. Rollox to deposit the waste in such a manner as to make it as little pervious to water as possible. It is well beaten down and carefully smoothed on the surface, and in this way no doubt the quantity of rain which finds its way through the heap, is materially diminished, but it is manifestly impossible that it can be altogether prevented, for we know that water penetrates through clay and the most compact rocks. Accordingly, a yellow or orange fluid may be seen escaping from crevices in the lower part of heap, and this flows into, and accumulates in the Pinkston Bog. Messrs. Tennant & Co. are of opinion that this water is not derived from their present waste heaps, but is due to land springs which have percolated through a quantity of waste which was deposited at the bottom of the Bog many years since, when the necessity for the precautions now used in storing the refuse were not understood. An attempt was made to intercept these land springs some years since, by

running a mine under the waste heap, by which it was expected that the water would have been carried away without coming in contact with the waste, but it was not attended with success, and did not sensibly diminish the flow of water into the Pinkston Bog. While there can be no doubt that a part of the water which gathers in the Pinkston Bog must be due to land springs, I am satisfied that part of it is rain water which has percolated through the waste. It has been ascertained by experiment that nearly half the rain which falls, even on compact clay soils, penetrates through them. Now, the annual rain-fall of Glasgow rather exceeds 35 inches, or 3500 tons a-year on every acre of land, and if we allow that only 500 tons per acre will percolate through the waste heap (being much less than half the quantity which passes through ordinary soils), and that the surface covered by waste is ten acres, there must, from this source alone, reach the Pinkston Bog, an average of 3000 gallons of water per diem, or 2·1 gallons per minute. It is impossible to examine the bottom of the waste heap after wet weather, without observing a quantity of the yellow fluid which has obviously escaped from it, and is flowing towards the Pinkston Bog.

The water accumulating in the Pinkston Bog, contains in solution a large quantity of sulphide of calcium, together with much soda and a little potash, but its composition varies very greatly at different times, being necessarily affected by the amount of rain which has fallen, and also by the length of time during which it has been exposed to the air. It always smells strongly of sulphuretted hydrogen, and on the addition of an acid that gas is freely evolved, and a copious deposit of sulphur is obtained.

A particular sample collected on the 4th October, 1864, as it flowed from the waste heap, was found to have a specific gravity of 1·053, and to contain 5010·5 grains of solid matter per gallon; when treated with an acid it gave off 36·31 grains of sulphuretted hydrogen or almost exactly 100 cubic inches per gallon. Of course, samples taken at different times are

found to vary greatly from this, and the water in the Pinkston Bog itself is generally much more dilute, being there mixed with land drainage from the surrounding district.

When this fluid is exposed to the air for a sufficient length of time oxygen is absorbed, and the sulphide of calcium is converted into the hyposulphite, a salt which has no smell, and is quite devoid of injurious properties, and if it could be preserved sufficiently long to complete this change, the fluid would become completly innocuous and incapable of producing nuisance.

In practice, however, this is impossible, as from the rapid accumulation of the water, it is necessary to get rid of it as quickly as possible. This used formerly to be done by allowing it to flow along the Pinkston Burn, which discharges into the Kelvin, about 100 yards above the Park. But the nuisance occasioned by it in the Kelvin was so great that Messrs. Tennant & Co. obtained permission to discharge it by the St. Enoch's Burn, and complaints having arisen in regard to this, a separate pipe was constructed about a year ago, by which it is now discharged into the Clyde at the foot of Dixon Street.

It will be readily gathered from what has been already said, that it is to this fluid that much of the nuisance complained of, is to be attributed. Its smell is extremely offensive, as it is constantly evolving sulphuretted hydrogen, and its effects are easily traced in the neighbourhood of the point at which it is discharged into the river, the paint on the sheds being blackened by it, and the metal gratings covered with sulphide. On coming in contact with the Clyde water, which contains a small quantity of iron, it is blackened by it, and to this a part of the colour of the water below the Bridges, which has been so conspicuous during the present season, is to be attributed. A still worse effect is produced at particular periods, when water containing a good deal of free acid is discharged from other manufactories, and comes in contact with the Pinkston Bog liquor. The acid then decomposes the sulphide of calcium, setting free sulphuretted hydrogen, and greatly increasing the offensive

smell, while the water is rendered perfectly white, like milk, by the sulphur which is separated often in great abundance.

There can, I think, be no difference of opinion as to the impropriety of allowing this fluid to be discharged into the river. The sulphuretted hydrogen which it evolves is not only very offensive to the sense of smell, but is highly injurious to the health, and must affect the Sanitary condition of those living along the river bank, and on board the shipping in the Harbour.

Another important question which has been raised is, as to the effect which these refuse matters exert on the copper sheathing of ships lying in the Harbour, and on iron vessels; and in investigating this question, I have thought it right to go into the matter with considerable minuteness, and to inquire into the effect of ordinary sewage upon these metals, —a question in regard to which there appears to be scarcely any definite information in existence.

The first experiments were made by suspending plates of copper and iron in the Clyde, just opposite the opening of the pipe by which the St. Rollox refuse is discharged at the foot of Dixon Street. The plates used were ten inches long by nine broad, and were suspended in the water for 62½ hours. The copper plate weighed—

Before immersion,......................	6555·86	grains.
After "	6560·70	"
Gain in Weight,...............	4·84	"

The surface had become perfectly black, and the increase in weight was due to sulphur which had combined with the copper and produced a layer of sulphide. By gentle rubbing this coating could be removed, and the plate then weighed 6540·1 grains, showing a loss of metallic copper to the extent of 15·76 grains.

A plate of iron of the same size, and suspended in the water for the same length of time, weighed—

Before immersion,......................	5613·44	grains.
After "	5619·66	"
Gain,............................	5·62	"

The gain in weight in this case consisted partly of sulphur and partly of oxygen, due to rusting of the iron, and when the coating was removed, the weight of the plate was 5586·30 grains, the loss of metallic iron thus amounting to 27·14 grains.

These experiments having shown the general nature of the action produced by the water, and also the inconvenience of carrying them on in the river itself, the inquiry was further prosecuted in the laboratory.

The fluid discharged from the mouth of the St. Rollox pipe in Dixon Street was used for this purpose. It contained, per imperial gallon,—

Solid matter, in solution,...............	212·32	grains.
" in suspension,............	16·16	"

The matters in solution consisted of sulphide of calcium, hyposulphite of calcium, soda, and traces of magnesia and potash. On the addition of an acid abundance of sulphur was precipitated, and sulphuretted hydrogen gas was set free.

Plates of sheathing copper, yellow metal, and iron, four inches long by three wide, were placed in glasses, each containing one pint of the fluid. After three days the results were as follow, the weights being grains:—

	Copper.	Yellow Metal.	Iron.
Weight before immersion,.........	790·30	714·23	744·16
„ after three days,...........	793·90	715·00	745·20
„ Gain,........................	3·60	0·77	1·04
„ after removing the coating,	782·50	713·80	742·20
„ Loss,........................	7·80	0·43	1·96

The results in this case were thus exactly similar to those obtained in the river, an increase in weight being always observed, due to the formation of a coating of sulphide: the chief point deserving notice being the comparatively small effect produced on yellow metal. The waters in which the copper and yellow metal were suspended were carefully examined, but neither copper nor zinc could be detected in them, from which it appears that the action had consisted

solely in the deposition of sulphur, and that none of the metal had been corroded away or dissolved during these three days.

In order to trace the effect of longer exposure to the fluid, another series of experiments was made, in which plates of the metals, three inches long by one-and-a-half broad, were placed in eight ounces of the fluid and their weights ascertained at intervals of a week. The results are contained in the following tables:—

COPPER.

	Weight, Grains.	Increase, Grains.
Before immersion,....................	308·60	...
After one week, ...	309·80	1 20
" two weeks,......................	310·65	0·25
" three weeks, ...	310·13	0·08
Total increase, ...		1·53

YELLOW METAL.

	Weight, Grains.	Increase, Grains.
Before immersion,....................	373·02	...
After one week,......................	373·15	0·13
" two weeks,......................	373·25	0·10
" three weeks,..................	373·27	0·02
Total increase, ...		0·25

IRON.

	Weight, Grains.	Increase, Grains.
Before immersion, ...	284·75	...
After one week,......................	285·65	0·90
" two weeks,......................	285·80	0·15
" three weeks, ...	285·56	Decrease. 0·24
Total increase,........................		0·81

From these experiments it appears that the action on the metals is most conspicuous during the first week, after which it

rapidly declines, and this result might be anticipated, because the coating of sulphide produced serves to a certain extent as a protector, and prevents the further action of the fluid. In the case of the iron it will be observed that the weight diminished at the end of the third week, and this was due to a portion of the coating of sulphide which was brittle and but slightly adherent, having scaled off on drying the plate previous to weighing.

The fluids in which the copper and iron were immersed had entirely lost their original yellow colour and smell of sulphuretted hydrogen, and, on the addition of an acid, no longer gave a precipitate of sulphur. That which had contained the yellow metal was entirely unchanged, and retained its original colour and smell. Neither copper nor zinc were found in the fluids, so that even during this lengthened period of exposure none of the metals had been corroded away.

The coating of sulphide on the copper and yellow metal was not effected by alkalies (soda or ammonia), but when a plate covered with it was immersed in sea water, copper was dissolved out, and a precipitate of carbonate of copper was found in the glass.

The refuse from the chlorine manufacture consisting, as already mentioned, chiefly of chloride of calcium with some free acid was subjected to a precisely similar series of experiments, but in this case yellow metal was not employed, as the effects produced on it were found to be but trifling.

COPPER.

	Weight, Grains.	Loss, Grains.
Before immersion,	324·46	...
After one week,	323·86	0·60
" two weeks,	323·68	0·18
" three weeks,	323·60	0·08
Total loss,		0·86

IRON.

	Weight, Grains.	Loss, Grains.
Before immersion,	265·50	...
After one week,	265·23	0·27
" two weeks,	265·00	0·23
" three weeks,	264·60	0·40
Total loss,		0·90

In this case, the action is of an entirely different kind from that produced by the fluid from the soda waste. Here corrosion of both metals commences at once, and though most active at first, is continuous, and in the case of the iron, is very marked during the third week. It must, of course, be understood that when iron is exposed for a considerable period to such a fluid, part of the corrosion is due to ordinary rusting such as would occur in any water; but with copper no such effect is observed, the action being entirely due to the substances contained in the water, and particularly to the free acid, and the diminished action during the latter weeks depends on the acid being neutralized by metal dissolved; and in proof of this, it was found that when the copper used in the experiment was introduced into a fresh quantity of the fluid, it lost, during an additional week of exposure, 0·32 grains, and this is what must actually occur in practice, owing to the continuous flow of the water. The fluids in which the copper and iron had been immersed, were found to contain these metals, which were also detected in the deposit which appeared at the bottom of the glass.

It is sufficiently obvious from these experiments, that both the refuse fluids from the St. Rollox Works exert a marked influence on copper and iron, though the nature of that action is conspicuously different in the two cases. In order to complete the inquiry, it appeared to me to be necessary to examine the water of some of the sewers discharging into the river, so as to ascertain their action on metals. As the examination of all the different sewage waters of the City

would have been an endless business, I contented myself with selecting the water of three sewers, which may be considered as representing different types. These were—1st, the Molendinar Burn, which contains the refuse from many different manufactories, as well as the drainage from a large inhabited district; 2nd, the St. Enoch sewer, containing a smaller quantity of manufacturing refuse; and 3d, the Carlton Place sewer, the water discharged from which may be described as *pure* sewage, being free from manufacturing refuse. The experiments were made in precisely the same manner as those already described, plates of the metals, three inches long by one-and-a-half broad, being introduced into eight ounces of the water.

MOLENDINAR BURN.

The water as taken from the sewer was quite neutral, but became faintly acid on standing.

Copper.

	Weight, Grains.	Loss, Grains.
Before immersion,	340·98	...
After one week,	340·93	0·05
" two weeks,	340·84	0·09
" three weeks,	340·83	0·01
Total loss,		0·15

Yellow Metal.

	Weight, Grains.	Loss, Grains.
Before immersion,	273·84	...
After one week,	273·77	0·07
" two weeks,	273·70	0·07
" three weeks,	273·70	0·00
Total loss,		0·14

Iron.

	Weight, Grains.	Loss, Grains.
Before immersion,	283·10	...
After one week,	282·87	0·23
" two weeks,	282·68	0·19
" three weeks,	282·60	0·08
Total loss,		0·50

The fluids did not contain any of the metals which had been immersed in them, but traces of copper were found in the deposit at the bottom of those which had contained the copper and yellow metal.

ST. ENOCH'S SEWER.

The water when collected was neutral, but became acid on standing.

Copper.

	Weight, Grains.	Loss, Grains.
Before immersion,	318·43	...
After one week,	318·40	0·03
" two weeks,	318·36	0·04
" three weeks,	318·36	0·00
Total loss,		0·07

Yellow Metal.

	Weight, Grains.	Loss, Grains.
Before immersion,	294·22	...
After one week,	294·14	0 08
" two weeks,	294·09	0·05
" three weeks,	294·06	0·03
Total loss,		0·16

IRON.

	Weight, Grains.	Loss, Grains.
Before immersion,	255·90	...
After one week,	255·66	0·24
" two weeks,	255·50	0·16
" three weeks,	255·33	0·17
Total loss,		0·53

Faint traces of copper were detected in the fluid in which that metal was placed; but neither copper nor zinc were found in that which had contained the yellow metal. The deposit, however, in both cases contained copper.

CARLTON PLACE SEWER.

COPPER.

	Weight, Grains.	Loss, Grains.
Before immersion,	346·05	...
After one week,	346·00	0·05
" two weeks,	346·00	0·00
Total loss,		0·05

IRON.

	Weight, Grains.	Loss, Grains.
Before immersion,	297·86	...
After one week,	297·72	0·14
" two weeks,	297·64	0·08
Total loss,		0·22

In this case it was considered unnecessary to continue the experiment for a third week.

It now remained only to examine the action of the water in the Harbour itself, and that of a pure water on the metals. For this purpose water was taken from the middle of the

river a few yards above West Street. It contained, per imperial gallon,—

	Grains.
Organic matter,	6·40
Fixed salts,	16·80
Total solids,	24·20
Suspended matter,	0·80

It was perfectly neutral.

Copper.

	Weight, Grains.	Loss, Grains.
Before immersion,	332·50	...
After one week,	332·42	0·08
" two weeks,	332·40	0·02
Total loss,		0·10

Yellow Metal.

	Weight, Grains.	Loss, Grains.
Before immersion,	379·90	...
After one week,	379·80	0·10
" two weeks,	379·80	0·00
Total loss,		0.10

Iron.

	Weight, Grains.	Loss, Grains.
Before immersion,	258·13	...
After one week,	257·90	0·23
" two weeks,	257·63	0·27
Total loss,		0·50

Plates of copper and iron were then exposed for a week in Loch Katrine water, when the former was found to be unchanged in weight, and the latter had lost 0·50 grains by rusting.

The conclusions to be drawn from the experiments contained in this Report must be divided into two heads.

I. As to the nuisance produced by the refuse matters from the St. Rollox Works.

II. As to their action on copper sheathing and on iron Ships lying in the River.

1st. As regards nuisance, I am of opinion that the refuse discharged by the High Street Sewer must be considered to be innocuous. It is free from smell, contains no substance capable of entering into putrefaction, and is consequently as little to be complained of as any refuse matter possibly can be. The water draining from the Waste Heap which accumulates in the Pinkston Bog, and is discharged by the pipe passing down Buchanan Street, is, on the other hand, of a most objectionable character. It contains in solution a large quantity of sulphuretted hydrogen, a gas of most offensive smell, known to be very injurious to animal life, and it scarcely admits of a doubt that the emanations from this refuse must to a greater or less extent affect the health of those exposed to them.

2nd. As far as the action of these refuse matters on iron is concerned, it appears to me that there is not much ground for apprehension. No doubt the corrosion is considerable and greater than that which would be produced by the rusting action of ordinary water, but it must be remembered, that in practice, iron is always carefully covered with tar, and when this is done, there is little risk of injury, especially as the refuse is largely diluted in the river. It appears, in fact, that the Clyde Water, from above West Street, had no greater action on uncovered iron than the Loch Katrine water, and its effect is merely to rust the metal.

It is different, however, with copper. As used for sheathing, its surface cannot be protected by any covering, and it is consequently exposed to the action of the fluids with which it may come in contact. Both the refuse fluids from St. Rollox act upon it, although in different manners.

That discharged by the High Street sewer corrodes it

in a marked manner. Its action is no doubt due to the free acid it contains, and might be diminished or entirely got rid of by adding to it a sufficient quantity of milk of lime before allowing it to flow into the sewer; and if this course were adopted and carefully carried out, all difficulty with it would be effectually got rid of.

The drainage from the waste heap acts in a different manner. It produces a coating of sulphide on the surface of the copper, which is to a certain extent a protection, and defends it from further action, and it is probable that if it were exposed only to this fluid, there would be comparatively little risk of continued injury. The great difficulty, however, which offers itself, is the varying nature of the influences to which the copper is exposed. The coating of sulphide of copper which is formed, is more liable to be affected by other agents than the copper itself, and the constant changes which occur in the water of the river at different times, are such that this coating may be corroded away from the surface of the metal, which is thus again exposed to the action of the refuse, and this effect may of course be repeated over and over again, and very rapid corrosion be produced.

The effect of sulphuretted hydrogen in producing the corrosion of copper sheathing is well-established, the subject having been carefully examined about twenty-five years since. At that time, the attention of the Lords of the Admiralty was directed to the rapid destruction of the sheathing of the ships on the West African Station, which was found to be, in some instances, corroded into holes within a very short space of time. The vessels of that squadron lay at the mouths of some of the rivers flowing through the low lying marshy lands of that country, and specimens of the water in which the ships lay having been sent home, were examined by the late Professor Daniell, who found them to contain from 0·67 up to 11·69 cubic inches of sulphuretted hydrogen per gallon, to which he traced the rapid corrosion of the sheathing. The same effect is well known in the merchant navy, and one of the largest copper smelters in South Wales

has stated that "the experience of between thirty and forty years has led his mind to the conclusion that sheathing copper will be as much or more injured on a nine months' voyage to and along the Coast of Africa, as by the wear and tear of from three to four years on any other trade." A similar effect was also observed some years since in the London Docks, although the corrosion in this case was less clearly established.

It is not to be expected that the action of the fluid from the St. Rollox waste heap should be so great as that of the African waters, because it is largely diluted by sewer water; but it is very obvious that it must exist to a certain extent, nor would it be right to attribute the entire effect on sheathing to it, because there are other sources from which sulphuretted hydrogen may be derived, and in particular it is often found to a small extent in sewage water.

That the refuse draining from the waste heaps may be rendered innocuous, is unquestionable. A sufficiently long and thorough exposure to atmospheric air, by which the sulphides are oxidised and converted into hypo-sulphites, would entirely deprive the fluid of all injurious effects, and not only prevent its action on copper, but also remove its smell and its bad effects on animal life. The perfect accomplishment of this change is entirely a money question; but it is greatly to be feared that it would be impossible to deal with so large a body of water except at a cost which would be ruinous. If it can be done at all, it will be necessary carefully to separate the drainage from the waste heap from land drainage which at present finds its way into the Pinkston Bog, and, if this is practicable, the more concentrated fluid might be subjected to processes which would be unremunerative if applied to it in its more diluted state. Whether this separation can be effected is a question for the engineer rather than the chemist. If it cannot be carried out, there is no remedy but the entire exclusion of this fluid from the River Clyde.

In concluding this Report, it is right for me to point out

that the facts detailed in it show that the question at issue is one of great extent. Taken in its broadest aspect, the purification of the Clyde would necessitate the exclusion from it of all refuse matters, both from manufactories and sewers. If this inquiry were extended to the matters discharged from other manufactories, it would probably be found that some of them are equally objectionable, and St. Rollox acquires its prominence only from its magnitude. Whether the matter should be taken up in detail, or some general measure be adopted, is a question which it is not for me to decide. But whatever conclusion may be arrived at on this point, there cannot be a doubt that the exclusion from the river of the St. Rollox refuse would be a step in the right direction.

THOMAS ANDERSON.

Glasgow, *15th August, 1865.*